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HOW PLANTS PROTECT THEMSELVES FROM COMPETITORS AND NATURAL ENEMIES

Pam Pittaway,
National Centre for Engineering in Agriculture
University of Southern Queensland, Toowoomba



Natural strategies to out-compete other plants:

Plants are the base of the food chain for all animals. Since they established themselves on land, plants have also been competing with each other for space, water and nutrients. Plants compete with each other by using one of three general strategies:

- **gap-grabbing** where rapid germination and early growth exploits gaps occurring within a plant community. Gap-grabbers often disperse their seed by wind. Rosette plants are good gap-grabbers, using their own early growth form to exclude others.
- **swamping** where climbers or rapidly growing stands of one species simply smother other plants; and
- **survivors** which are specialists adapting their growth requirements to exploit environments that other species cannot tolerate.

Under cultivation the soil surface should be managed to avoid the **introduction** of **swampers** and to avoid **gaps**. Weed seeds can be introduced in manure, mulch or in imported topsoil. **Composting** manure before use will kill weed seeds, and the application of composts over time will replace the need to bring in topsoil. Covering the soil with crop residues or mulch also denies access to weed seeds. Using locally grown mulch will reduce the likelihood of importing exotic weeds. If weed seeds are present, paper mulches can be used to minimise the chances of seed germination. **Swampers** may also be spread locally in bird droppings, so keep an eye out and remove such seedlings well before they can set seed!

Within crops, **gaps** can be managed by minimising the spacing between preferred plants. This can be achieved by maximising the planting density of the preferred species, or by using **living mulches**. Ground cover species, - plants spreading their foliage low over the soil surface, can be used effectively to exclude gaps. Clovers and some relatives of the peanut can be sown under more vigorous crop plants, to provide a living 'filler'. **Living mulches** have been sown successfully in crops such as maize and cucurbits, crops with sufficient vigour to **outcompete** the groundcover species. In the crop context living mulches can also be used as a **green manure** to improve the soil (ie not harvested but residues left on the soil). However if the preferred plant is sensitive to competition, a conventional straw or 'yard trimmings' mulch can be used to modify any spaces, making them unsuitable for weed seed germination.

Natural strategies to outcompete herbivores:

Plants that have succeeded in dominating spaces in the landscape, also have to fight off herbivores eager to share in their bounty. Key plant defence strategies are the use of:

- **Physical barriers** such as waxes, hairs and spines, and
- **Chemical barriers**, both pre-circulating and induced after attack.

Pre-circulating **chemical barriers** include generally **toxic** compounds such as pyrethrum, nicotine and cyanide, and **repellent** compounds with acidic or bitter flavours. **Unthrifty** plants lacking the energy reserves to produce high levels of these natural chemicals are more **attractive** to insect attack. If plant vigour is not restored, such plants will die back after each attack, eventually dying outright. **Repellent** chemicals do not kill herbivores, rather the preferred species is protected by modifying herbivore behaviour!

In general **plant toxins** target animals, most particularly insects (**insecticides**). Insects are animals like us, sharing the same basic cell type. Therefore **insecticides be they naturally produced or man-made**, are highly likely to affect the cells of other animals - such as ourselves!

Exceptions are where the **toxin** targets insect moulting (when an insect sheds its external skeleton to expose the new, larger one below). Mammals do not moult, hence **toxins** targeting the hormones controlling moulting are less likely to affect us. Most **insecticides** kill on contact, killing beneficial and pest species indiscriminately (refer to **figure 1**). The majority of insects and other soil-dwelling animals **are not plant pests**, but are vital in maintaining nutrient cycles and the physical structure of soils.

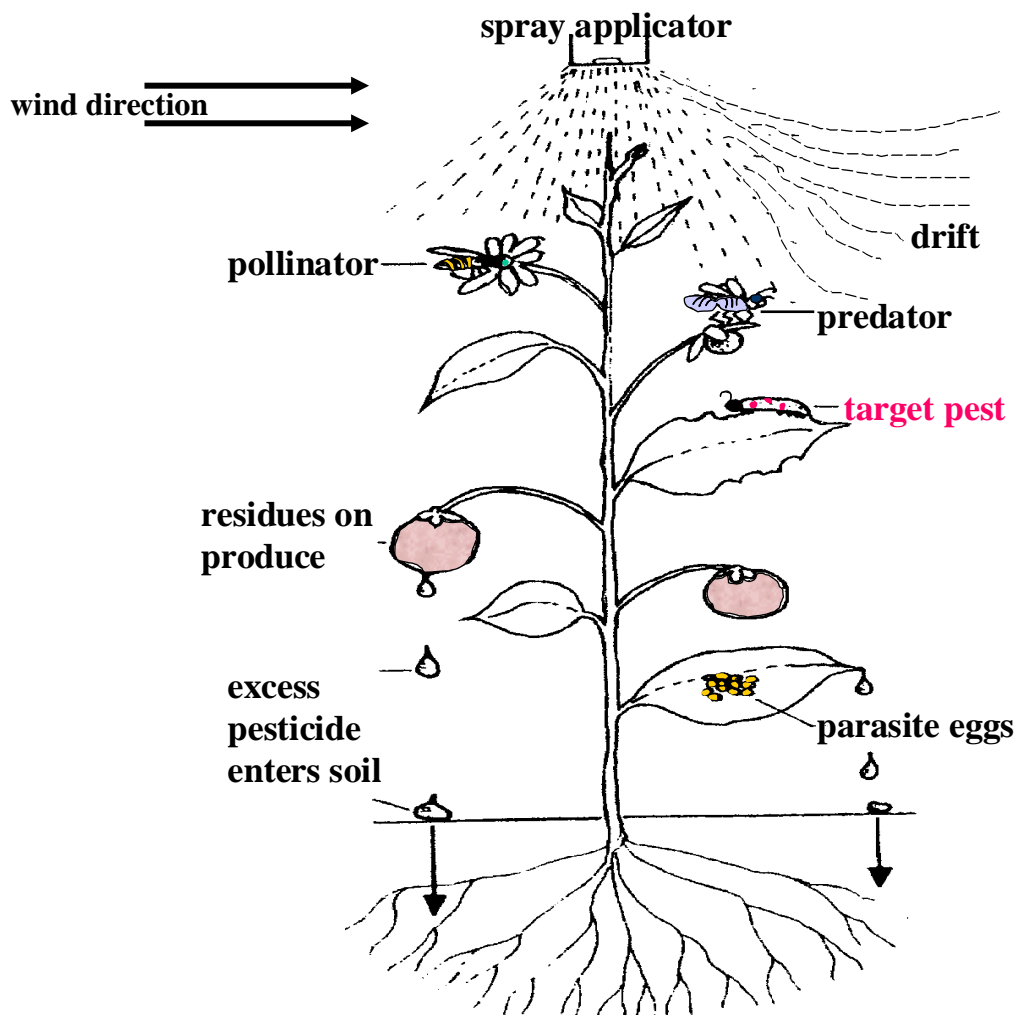


Figure 1. Unintended consequences of use of a contact insecticide for pest control.
Modified from Fenemore (1982) Plant Pests and their Control. Butterworths.

The fate of chemicals in the soil:

As little as 10% of pesticides sprayed actually reach their target (**Figure 1**). Whilst the pesticides remain biologically active, many non-target soil organisms may be destroyed. **Toxic** chemicals are biologically active because of their chemical structure, and this same chemical structure may interact with soil clay particles and humus. In time, most **toxic** chemicals are **deactivated** by this process. Indeed in some biologically active soils the effectiveness of some pesticides has reduced, as a consequence of the increased activity of microbes using them as food! However persistent chemicals including those using heavy metals (eg zinc and copper) as the active ingredient, can reduce the activity of soil animals and microbes, reducing the fertility of the soil (see ‘Can Do’ sheet 4: What is a Healthy Soil?)

Strategies to avoid pest outbreaks

Like many other animals, insects show behavioural preferences for different colours, surface textures and odours. However they have a very limited capacity for learning. As a consequence, insects will instinctively move towards any stimuli perceived as **attractive**, and move away from anything perceived as **repellant**. Examples of successful strategies that manipulate insect behaviour are given below:

- **Selection and maintenance of resistant or tolerant crop varieties**
Check on the availability of crop varieties that are **resistant** (pest is not attracted to the variety) or **tolerant** (continues to yield despite being attacked) to key pest species. Maintain **good crop nutrition** to ensure that the plants can produce their natural protectant chemicals. Pest species are **attracted** to unthrifty plants (see **Figure 2**).
- **Selection of a planting window to avoid pest attack**
The life cycle of many pest species is strictly regulated by seasonal temperature and/or rainfall triggers. Planting susceptible crops **outside** peak pest activity times (**window of opportunity**) avoids pest damage (eg grow tomatoes in winter to avoid Qld fruitfly)

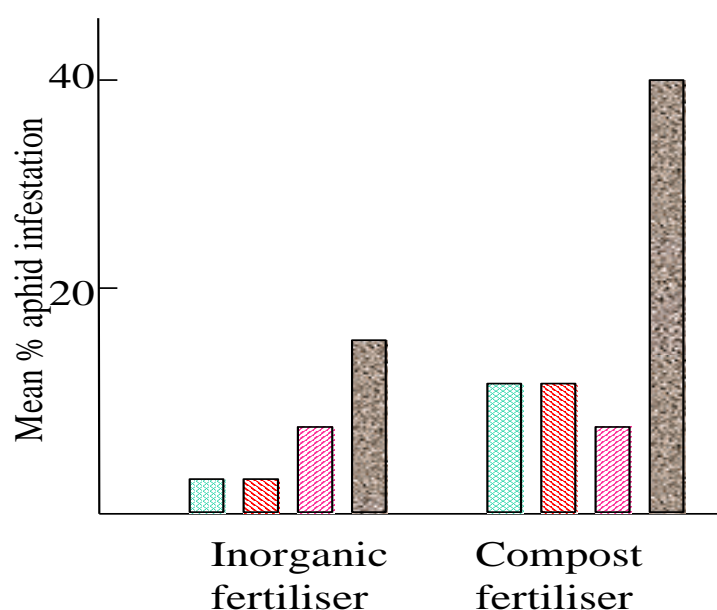


Figure 2: Effect of living mulches (white clover = diamonds, red clover = backslash, strawberry clover = forward slash) on reducing the extent of aphid infestation on broccoli. Bare ground controls = stippled bars. One series of the groundcover treatments were fertilised to meet the needs of the crop for N, P and K (left hand series of bars), the other had slow-release compost applied. The nitrogen-stressed compost-treated plants attracted higher aphid numbers, particularly in the absence of living mulches. Modified from Costello (1994) *Biological Agriculture & Horticulture* 10: 207-222

- **Selection of companion plants to minimise pest attack**
Growing the preferred crop with selected plant species as living mulches or planted in alternating strips, can reduce pest attack in several ways (refer also to **Figure 2**):
via **repellance**: companion plants emit chemicals that repel the pest species (eg marigolds repel root knot nematode)
via **attraction**: companion plants attract and harbour either natural enemies of the pest species, or serve as a preferred alternative host for the pest species
via **overflight**: companion plants including crop stubble are taller than the preferred crop, causing insects to fly over the undetected crop
- **Selection of non-host crop rotations and control of alternative host plants**
Denying the pest species alternative hosts (eg the pest 28-spotted ladybird builds up on the weed blackberry nightshade) will reduce the local pest population, **before** the preferred crop is planted.
- **Local mass-release of natural enemies**
Predators of many pest species are now commercially available from specialised insect rearing companies (eg Bugs for Bugs located in Mundubbera, Qld).
- **Local application of microbial pesticides**
Selected microbes (bacteria, fungi, protozoa and viruses) known to cause disease in key pest species are commercially available. In contrast to conventional insecticides, these specialised pathogens can invade only a very limited range of insect species. Hence the timing of application to match the most vulnerable life phase of the target pest species is critical. For example the bacterium *Bacillus thuringiensis*, (trade name Dipel or thuricide targets caterpillars, Vectobac or Teknar target mosquito larvae) must be eaten by caterpillars (or wrigglers) at an early growth stage to be effective.
- **Physical immobilisation of pest species**
Small insects such as aphids, scale and whitefly can be trapped in fluid films, or on sticky paper. Placing strips of sticky yellow paper or bowls with water and detergent will trap aphids (yellow attracts aphids, white attracts whitefly).

Using chemicals (natural or man-made) wisely:

Remember, as a general rule, pesticides are **not selective**. **Selectivity** is managed by applying chemicals at specific growth phases when preferred plants will be **least affected**, at rates that will minimise damage to **non-target** species. However if **repellant** chemicals are selected, then neither the crop, nor the pest nor non-target species will be damaged!.

Some **toxins** can be applied **systemically** (to circulate within the plant), meaning that only those animals feeding on the plant will be affected. If using **contact toxins**, apply them as much as possible to where the pest is. For example if the pest preferentially feeds on the upper leaves, spray these and avoid spraying the lower leaves where spiders and other insect predators often lurk. If targeting slugs and snails, place toxic **baits** inside upturned cups or dishes, sites where the target pests will preferentially shelter.

At all times, toxic chemical intervention should be the last resort. Ensure the vigour and harvest of your crop by implementing the best preventive strategies, that minimise the likelihood of pest outbreaks occurring in the first place.